Egypt from basin to the perennial system of irrigation is now due, and to meet these needs this barrage will have to be constructed.

Besides these works which are about to be constructed on the Blue and White Niles, two other projects of which the need in the future can be foreseen to complete the control of the Nile supply are briefly discussed. One of these is the Lake Albert dam, by means of which it is proposed to hold up a reserve store of water in the Albert Lake, which will be conveyed to the White Nile by a channel or channels so planned as to avoid the loss of water which now takes place in wide, shallow valleys where the sadd marshes are situated. The other scheme, which is even more briefly outlined, is the provision of a dam on the upper reaches of the Blue Nile to store 7000 million cubic metres of water, of which part would be kept as a permanent reserve in case of low floods, and the balance used to irrigate the cotton crop on one-third of a million feddan area in the Sudan. Nothing has yet been done on either of these projects, and no details are published in the report; they are only indicated as works which must eventually be undertaken to provide the necessary water for agriculture in arid and semi-arid areas of the Nile basin.

The report contains a large amount of valuable information on the utilisation of water under the special conditions which prevail in Egypt. The requirements of agriculture are fully stated by the responsible authorities of Egypt and the Sudan; detailed estimates of the amount of water which is available at various seasons are also given as the result of a long series of measurements which have been made in recent years. This collection of hydrographical data brings those which were previously available up to date, and supplements them by much information of greater accuracy on which the present projects have been based.

With a rapidly increasing population the occasional occurrence of such disastrously low floods as that of 1913 has carefully to be guarded against; on the other hand, the growing demands of cultivators in Egypt, and the needs of the Sudan, which will be increasing for years to come, call for the most careful investigation of the hydrography of the Nile, for, while the supply of water is shown to be sufficient to meet all anticipated requirements, this can be done only by a full control of the supply and a careful regulation at all seasons by suitable works.

Poynting's Scientific Papers.

Collected Scientific Papers. By Prof. J. H. Poynting. Pp. xxxii + 768. (Cambridge: At the University Press, 1920.) Price 37*s.* 6*d.* net.

THESE papers make a stately volume of considerably more than 700 pages, and our thanks are due to the editors, Mr. Guy Barlow and Dr. Shakespear, for the ability with which they have performed their work, a work which, as old pupils of Poynting, must have been to them a labour of love. The volume contains an excellent portrait, and the type, paper, and binding are worthy of the Cambridge University Press. I think everyone, even though he may have thought himself well acquainted with Poynting's work, will find here something which he sees for the first time, for the volume includes not only papers from such normal sources as the Transactions and Proceedings of the Royal Society and the *Philosophical Magazine,* but also others from the *India Rubber Journal,* the *Hibbert Journal,* the "Encyclopædia of Biblical Literature," the *Mason College Magazine,* and the *Inquirer.* In addition to the classical papers on the flow of energy in the electromagnetic field, on the pressure of light, and on the density of the earth, there are others on the drunkenness statistics of the large towns, on the fluctuations in the price of wheat, on the experiences of one who overtook the waves of light, a criticism of Herbert Spencer's "First Principles," and a paper on physical law and life. To those who knew Poynting, these informal papers have a special charm, for they will find in them much that will recall memories of long-past talks; they recall his quiet humour, the freshness of his views, his courtesy in debate, his dread of saying or doing anything that could hurt the feelings of anyone who did not hold his own views on the point at issue. Among the seventy papers in this book, there are not more than two or three that could be called controversial, and it is characteristic of these that he criticises his opponent as if he loved him; and, even when the author under notice has laid himself more than usually open to criticism, Poynting is not content with pointing out the unsoundness of his statements; he suggests that he must really have meant something else, something much more reasonable.

Another feature of the book is that running throughout the papers is a view of the philosophy of physics which is now very prevalent, but which Poynting was one of the first in this country to adopt. This view is summarised in the paper on "Physical Law and Life"; and though this paper was not published until 1903, he had then held the views expressed in the following quotation for a long time:—

> "I have no doubt whatever that our ultimate aim must be to describe the sensible in terms of the sensible. But I see, too, what gulfs there are still separating one part of our knowledge from another, and I see no harm in throwing temporary bridges of hypotheses across these detached gulfs to connect what would otherwise be detached regions. They allow us to pass to and fro with ease, and have been, and are, of enormous help to us in our exploration of Nature. But we must bear in mind that we may have many types of connecting bridge, many forms of hypothesis equally serviceable, all perhaps to be broken down and abandoned when we have filled in the gulfs which they crossed, and have made firm roadways built of sensible fact."

As another illustration of the modernness of his point of view, I may take a sentence from his address as president of Section A at the meeting of the British Association at Dover in 1899:—

> "Another illustration of the illegitimate use of our hypothesis as it appears to me is the attempt to find in the ether a fixed datum for the measurement of material velocities and accelerations, a something in which we can draw our co-ordinate axes so that they will never turn or bend. . . . We could only fix positions and directions in the ether by buoying them with matter. We know nothing of the ether except by its effects on matter, and, after all, it would be the material buoys which would fix the position, and not the ether in which they float."

Poynting's scientific work concentrated in the main on three subjects: the flow of energy in the electromagnetic field, researches on gravity, and on the pressure of light. It is by the first of these that he is perhaps most widely known, and with which "Poynting's vector" will always associate his name. It was Poynting who introduced the idea that the energy in the electromagnetic field flows in the direction of a vector now known as "Poynting's vector," which is at right angles to both the electric and the magnetic forces, the rate of flow being proportional to the product of these two forces and the sine of the angle between them. Thus, whenever there are both electric and magnetic forces, there is flow of energy unless the two forces are in the same direction, and wherever there is flow of energy there are both electric and magnetic forces.

The importance we attach to this result will depend upon the view we take of the localisation and identification of energy. If we confine ourselves to the dynamics of a system of bodies acted upon by assigned forces, we may regard the kinetic and potential energies of the system as names for certain functions of the velocities and co-ordinates of the bodies which satisfy a sufficient number of equations to enable the co-ordinates of the system to be determined at any time if the co-ordinates and velocities at some previous time are known. The idea of localisation of energy is foreign to this point of view, for the amount of kinetic energy possessed by any member of the system will depend upon the choice of axes to which the velocities are referred, while when we regard the potential energy of two charges separated by a distance r as $-ee'/r$, the idea of localisation of energy is unmeaning and immaterial. When, however, we discard the idea of action at a distance, and regard the space between bodies as the seat of the influences they exert on each other, the question of the localisation of energy at once becomes prominent. Thus, to take a definite case, we may regard all energy as molecular in structure, and made up of a large number of units, all the units possessing the same amount of energy, and the energy of each unit remaining unchanged as the unit moves about. Thus the amount of energy in any region is proportional to the number of units of energy in that region, and changes in this amount are due to the motion into or out of this region of units of energy. From these points of view the motion of these units is what governs the behaviour of the system, and the flow of these units is represented by Poynting's vector. Poynting's work on the pressure of light and his determinations of the density of the earth by an ordinary balance are great tributes to his skill and insight as an experimenter. The method with the ordinary balance is, as he himself acknowledges, inferior to that employed by Boys, and yet Poynting was able to get, by care and skill, a result comparable in accuracy with that obtained by the better method.

Poynting's experimental skill and his power of devising simple apparatus which could be made in the laboratory and yet give results of the highest accuracy were quite remarkable, and the simplicity of the means by which he got his results was not surpassed either by Stokes or by the late Lord Rayleigh.

To read through everything that a man has published during forty years of scientific work, extending over a period remarkable for new discoveries and the introduction of new ideas, is a severe test for his reputation; it might be expected that much would seem musty and out of date; this, however, is not so with Poynting's papers, for in them there is little or nothing which in any way conflicts with modern ideas.

Poynting's researches, important as they are, form but a part of his life's work. He was a very successful teacher, and as professor of physics at Mason's College from its foundation he created and developed the flourishing school of physics at the University of Birmingham. He took his full share of the large amount of business and organisation required to carry on the work of his university and the scientific societies with which he was connected, and as a magistrate he took part in the civic life of Birmingham. Everyone who met him in these capacities found him the most delightful and courteous of colleagues, while to many he was the beloved and valued friend.

J. J. THOMSON.

Scottish County Geographies.

(1) *Banff and District.* By Allan Edward Mahood. Edited by Dr. E. I. Spriggs. Pp. xvi + 388. (Banff: *The Banffshire Journal,* Ltd., 1919.) Price 10*s.* 6*d.*

(2) *Orkney and Shetland.* By J. G. F. Moodie Heddle and T. Mainland. Pp. xii + 167. (Cambridge: At the University Press, 1920.) Price 4*s.* 6*d.* net.

(3) *Caithness and Sutherland.* By H. F. Campbell. Pp. ix + 168. (Cambridge: At the University Press, 1920.) Price 4*s.* 6*d.* net.

(4) *Kirkcudbrightshire and Wigtownshire.* By William Learmonth. Pp. ix + 149. (Cambridge: At the University Press, 1920.) Price 4*s.* 6*d.* net.

(5) *Dumbartonshire.* By Dr. F. Mort. Pp. viii + 155. (Cambridge: At the University Press, 1920.) Price 4*s.* 6*d.* net.

(1) DR. MAHOOD'S "Banff" belongs to the best class of local guide-book. It is the result of a careful study of the area by a number of enthusiastic students; the bulk of the material has been collected by Dr. Mahood, of Duff House Hospital. Chapters have been contributed by various local authorities, and the whole has been condensed and edited by Dr. E. I. Spriggs, and its stores of information are rendered accessible by an excellent index. The book is a compendium of the geography, history, and antiquities of the district, and should add greatly to the profitable enjoyment of a stay there by any intelligent visitor; and, as it gives practical guidance to the special points of interest, it should stimulate the study of the local archæology and natural history.

The walks around Banff are classified according to their length, and the programme of longer excursions refers to the numerous antiquities and to such features as the musical sands, the dunes of Culbin, and the remarkable southerly deflection of the plumb-line at Cowhythe, which would indicate a position nearly a fifth of a mile in error. Banff Museum is rich in local material, and the chapter on it is a useful introduction to the local archæology and history. Banff was the home of Thomas Edwards, the self-made naturalist with the Smiles-made reputation, who, amongst other contributions to science, demonstrated that the shell beds on the 25-ft. raised beach at Boyndie is a Neolithic kitchen-midden.

The geology of the area includes much of interest, and special attention has been recently directed to it by Mackie's discovery of the plant-bearing cherts of Rhynie, which have been proved by the researches of Kidston and Lang to be the oldest known land flora, and to contain, exquisitely preserved, the plants of the period when land was being first clothed with vegetation. The discovery of this flora is the most epoch-making in palæobotany in recent years. The account of the geology is well up to date; it recognises the Old Red Sandstone as a river-made deposit, but that view need not have been assigned to America, as it had been previously advanced in this country. A remark on the work of Prof. Jehu and D. Campbell on the Highland Border Series may be misunderstood as implying that some of the Highland schists have been thus proved to be Lower Palæozoic, whereas that work strongly strengthens the case for the pre-Palæozoic age of those schists.

(2–5) The volumes of the Cambridge University County Series suffer in contrast with that on Banff by the absence of references, as even a short bibliography would be of great assistance to the students for whom these admirable manuals would be of special service. Moreover, the one author deals with all branches of the subject—history, geography, archæology, ethnology, geology, natural history, and economics—and has to write on some questions with which he is not fully familiar. Consistency between the manuals and complete accuracy are possible only by editorial supervision. In this series the authors appear to be given entire independence provided they conform to the prescribed plan.

A student who turns to these volumes to compare the evidence on some question from different parts of Scotland finds puzzling inconsistencies. Thus the circular megalithic towers known as brochs, the most remarkable of Scottish antiquities, are attributed in the account of those in Caithness and Sutherland to the early Iron age, and therefore to be pre-Roman; whereas the volume on Orkney adopts the older and less probable theory that they were built as shelters against